the eared seals, have the "sagittal groove," etc., as above described, as do also the males till they have attained nearly their full size. The sagittal crest in the males of *Eumetopias* and *Callorhinus* rises at first as a double ridge on each side of the sagittal suture, beginning at the hinder part of the skull. It develops most rapidly in its posterior part, and gradually extends anteriorly to a point opposite the orbital processes. Gradually the laminæ of this double plate become soldered into one, uniting first posteriorly, while anteriorly the crest remains composed of two closely applied thin plates, which, in old age, become firmly united the whole length. The sagittal crest in old male skulls of *Zalophus* hence differs from the corresponding crest in *Eumetopias* and *Callorhinus*, only in being relatively somewhat higher, and in being more produced anteriorly. I am not sure, however, that in very aged animals even this slight difference would be constant. In one of the skulls of *Zalophus* I have seen, the two plates were not entirely soldered at their anterior end, thus indicating their development primarily as a double plate, as in *Eumetopias* and *Callorhinus*. The only other character given as separating these two groups — that of the rostral profile — I deem too trivial to require more than the incidental remark already given to it.

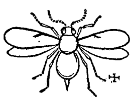
In concluding, I may add that the deservedly high standing of my critic as a naturalist seemed to demand from me, in justice to myself, some notice of his sweeping criticisms, especially since not merely the assumed value of the characters given by me as distinguishing what I considered to be two primary groups of the *Otariadæ* were questioned, but also even the existence of such distinctions; but more especially it was due to the interests of science that his incorrect diagnosis of one of the two groups he considers as the two primary groups of this family, should not pass unnoticed, since on this error was based a new classification of the *Otariadæ*. Having done this, the writer will here let the subject rest.—J. A. A.

THE EARLY STAGES OF ICHNEUMON PARASITES.*—These embryological studies were made by Prof. Ganin on the eggs of Platygaster, Polynema, Teleas and Ophioneurus, which are minute

*Beiträge zur Erkenntniss der Entwickelungsgeschichte bei den Insecten. Von M. Ganin, aus Charkow. Siebold and Kölliker's Zeitschrift. 1869, pp. 381-451, with 4 plates. Leipzig.

ichneumon egg-parasites of the hymenopterous family Proctotrypidæ, of which the Platygaster of the Canker worm (Fig. 14) and *Platygaster error* Fitch (Fig. 15, copied from the "Guide to the Study of Insects") are familiar examples. It has been generally supposed that the larvæ of these egg-parasites were little footless, white maggots, like the young of other ichneumon flies. In the valuable and well illustrated memoir before us, however, the author, a Russian professor who pursued these studies under the direction of the distinguished Leuckart of Giessen, shows that the insects pass through a series of remarkable changes before assuming the final, and more normal larval state, the series of changes indicating a succession of metamorphoses, comparable, as Ganin says, to the hyper-metamorphosis of Meloë and Sitaris.

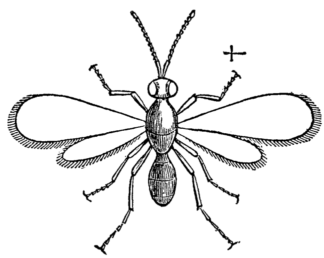
Fig. 14.



Egg-parasite of Canker Worm.

The earliest stages of the embryo of Platygaster were observed in the youngest specimens of Cecidomyia larvæ, or dipterous gall maggots, which live exposed on young willow leaves. The female sometimes lays from twelve to fifteen eggs in the body of the larval Cecidomyia, though usually not so many. When they are numerous they are not all laid at one time, as the embryos are found to be in different stages of development. Usually only one out of the whole number of embryos leaves the body of its host as a fly. The eggs are generally laid in the masses of cells composing the "fatty body," and in the interior of (or beneath, *im innern*) the supraœsophageal ganglion of the Cecidomyia larva. Not one species only, but sometimes three species of Platygaster oviposited in the body of a single gall-fly maggot. These differed from each other in the size of the egg, and very strikingly in the form of their first larval stages. One of these Platygasters lays its eggs (from one to six) almost exclusively in the intestines of the gall maggot. The eggs of the other species of Platygaster are usually found in the body-cavity of their host. It is sometimes impossible to find a Cecidomyia larva which is not infested by these parasites. The death of the host occurs shortly

Fig. 15.



Platygaster error.

before pupation, at least Ganin could never find any Platygaster in any other situation than in the larva of Cecidomyia.

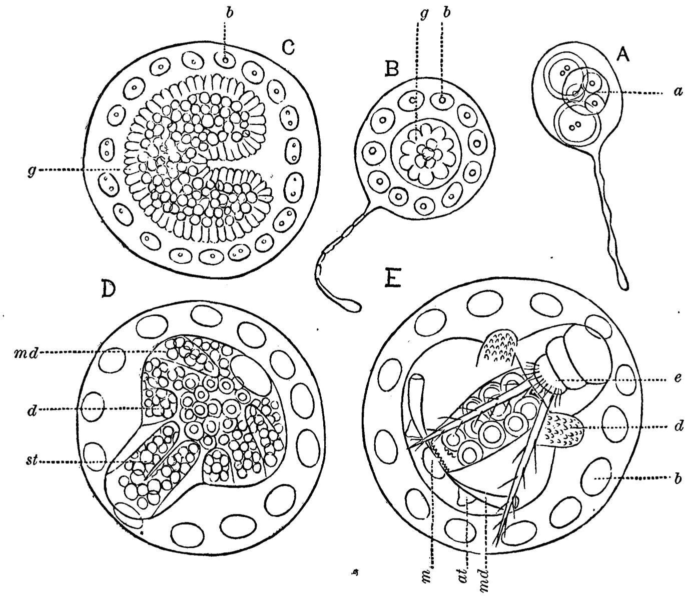
The eggs of Platygaster taken from the ovary of a female two or three days after leaving the pupa, are long, oval, with a long thin stalk, and a very elastic shell (chorion). During the development of the embryo the egg increases in size from ten to fifteen times its original bulk. The eggs of this and the other genera mentioned below, differ from those of other insects in wanting the nutrient yolk-cells (ernährungsdotter). The entire egg consists of the formative yolk-cells (bildungsdotter). This formative yolk appears as a pale, thick, structureless protoplasm, in which the so-called yolk cellules, or nuclei (dotterkörnchen), are wanting. In the central part of the egg we find in the direction of its longer axis, a considerable number of transparent molecular cellules; but at the periphery of the egg, these most minute of all organized histological structures are wanting. The protoplasm of the egg is wholly structureless.

The ovarian egg is formed by the growth of a cell lying at the hinder pole of the egg tube. This egg-cell has at first no membrane; its transparent, viscid protoplasm gives origin to the yolk. The small, sharply contoured nucleus of the egg is no other than the primitive vesicle of the egg. The primitive vesicle disappears when the imago leaves the pupa. Its ground substance, as also that of the granular portion, resembling the white of an egg, is converted into a fine, molecular mass, which is found in the central part of the ripe egg. The number of egg tubes in each ovary is thirty, corresponding to the number of eggs in each tube. The ovary of Platygaster differs from that of all other insects in that it is a closed tube, or sac. Hence it follows that at every time an egg is laid, the egg tube is ruptured. This was also observed in the Sheep tick (Melophagus) by Leuckart, and in certain flies (Limnobia, Psychoda, and Mycetobia) by Ganin.

The earliest stage observed after the egg is laid, is that in which the egg contains a single cell with a nucleus and nucleolus. Out of this cell (Fig. 16 *A*, *a*) arise two other cells. The central cell (*a*) gives origin to the embryo. The two outer ones multiply by subdivision and form the embryonal membrane, or "amnion," which is a provisional envelope and does not assist in building up the body of the germ. The central single cell, however, multiplies by the subdivision of its nucleus, thus building up the body of the

germ. Fig. 16 *B*, *g*, shows the yolk or germ just forming out of the nuclei (*a*) ; and *b*, the peripheral cells of the blastoderm skin, or "amnion." Fig. 16 *C* shows the yolk transformed into the embryo (*g*), with the outer layer of blastodermic cells (*b*). The body of the germ is infolded, so that the embryo appears bent on itself. Fig. 16 *D* shows the embryo much farther advanced, with the two pairs of lobes (*md*, rudimentary mandibles ; *d*, rudimentary pad-like organs, seen in a more advanced stage in *E*), and the bilobate tail

Fig. 16.



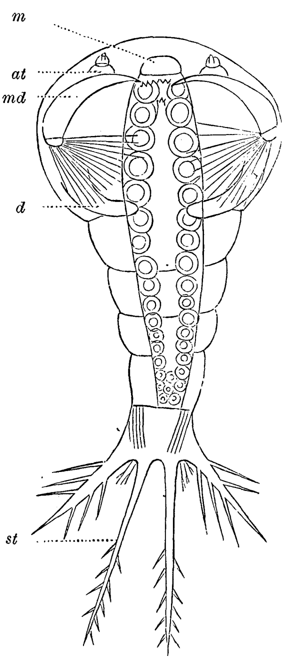
Development of Egg-parasite Platygaster.

(*st*). Fig. 17 (*m*, mouth ; *at*, rudimentary antennæ ; *md*, mandibles ; *d*, tongue-like appendages ; *st*, anal stylets ; the subject of this figure is of a different species from the insect previously figured, which, however, it closely resembles) shows the first larva stage after leaving the egg. This strange form, the author remarks, would scarcely be thought an insect, were not its origin and farther development known, but rather a parasitic Copepodous crustacean, whence he calls this the *Cyclops-like stage*. In this condition it clings to the inside of its host by means of its hook-like jaws (*md*), moving about like a Cestodes embryo with its

well known six hooks. The tail moves up and down, and is of but little assistance in its efforts to change its place. Singularly enough, the nervous, vascular, and respiratory systems (tracheæ) are wanting, and the alimentary canal is a blind sac, remaining in an indifferent, or unorganized state. How long it remains in this stage could not be ascertained.

The second larval stage (Fig. 18; *œ*, œsophagus; *ng*, supraœsophageal ganglion; *n*, nervous cord; *ga*, and *g*, genital organs; *ms*, bands of muscles) is attained by means of a moult, as usual in the metamorphoses of insects. With the change of skin the larva entirely changes its form. So-called hypodermic cells are developed. The singular tail is dropped, the segments of the body disappear, and the body grows oval, while within begins a series of remarkable changes, like the ordinary development of the embryo of most other insects within the egg. The cells of the hypodermis multiply greatly, and lie one above the other in numerous layers. They give rise to a special primitive organ closely resembling the "primitive band" of all insect embryos. The alimentary canal is made anew, and the nervous and vascular systems now appear, but the tracheæ are not yet formed. It remains in this state for a much longer period than in the previous stage.

Fig. 17.



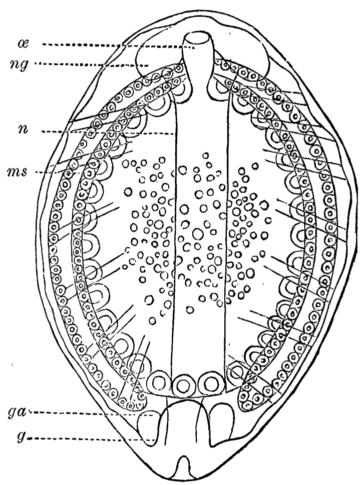
First larva of Platygaster.

The third larval form only a few live to reach. This is of the usual long, oval form of the larvæ of ichneumons, and the body has thirteen segments exclusive of the head. The muscular system has greatly developed and the larva is much more lively in its motions than before. The new organs that develop are the air tubes and fat bodies. The "imaginal discs" or rudimentary portions destined to develop and form the skin of the adult, or imago, arise in the pupa state, which resembles that of other ichneumons. These discs are only engaged, in Platygaster, in building up the rudi-

mentary appendages, while in the flies (Muscidæ and Corethra) they build up the whole body, according to the remarkable discovery of Weismann.

The origin of the sting is clearly ascertained. Ganin shows that it consists of three pairs of tubercles, situated respectively on the 7th, 8th, and 9th segments of the abdomen* (Fig. 19, *tg*). The labium is not developed from a pair of tubercles, as is usual, but at once appears as an unpaired, or single, organ. The pupa state lasts for five or six days, and when the imago appears it eats its way out through a small round opening in the end of the skin of its host, the Cecidomyia larva.

Fig. 18.



Second larva of Platygaster.

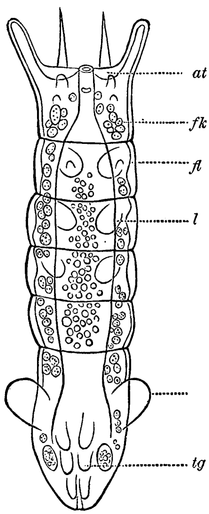
Not less interesting is the history of the development of a species of Polynema, another egg-parasite, which lays its eggs (one, seldom two) in the eggs of a small dragon fly, *Agrion virgo*, which oviposits in the parenchyma of the leaves of water-lilies (Nymphæa). The eggs develop as in Platygaster. The earliest stage of the embryo is very remarkable. It leaves the egg when very small and immovable, and with scarcely a trace of organization, being a mere flask-shaped sac of cells.† It remains in this state five or six days.

* The reviewer, in his "Guide to the Study of Insects," p. 14, and previously, in the Proceedings of the Boston Society of Natural History, vol. xi, p. 393, 1868, has shown that the ovipositor of Bombus arises from three pairs of tubercles like those figured by Ganin, but the two anterior pairs are represented as both arising from the same (penultimate) segment of the abdomen. It is not improbable that at an earlier period each pair arises from a separate segment, as in Platygaster. Later studies have convinced the reviewer that these organs are homologous with the abdominal jointed stylets of many insects, and consequently with the legs and appendages of the mouth; and even with the "spring" of Poduræ.

†This reminds us (though Ganin does not mention it) of the development of the embryo of Julus, the Thousand legs, which, according to Newport, hatches the 25th day after the egg is laid. At this period the embryo is partially organized, having faint traces of segments, and it is still enveloped in its embryonal membranes and retains its connection with the shell. In this condition it remains for seventeen days, when it throws off its embryonal membrane, and becomes detached from the shell.

In the second stage, or Histriobdella-like form, the larva is, in its general appearance, like the low worm to which Ganin compares it. It may be described as bearing a general resemblance to the third and fully developed larval form (Fig. 19, *tg*, three pairs of abdominal tubercles destined to form the sting; *l*, rudiments of the legs; *fk*, portion of the fatty body; *at*, rudiments of the antennæ; *fl*, imaginal discs, or rudiments of the wings). No tracheæ are developed in the larva, nor do any exist in the imago (Ganin thinks, that as these insects are somewhat aquatic, the adult insects flying over the surface of the water, the wings may act as respiratory organs, like gills.) It lives six to seven days before pupating, and remains from ten to twelve days in the pupa state.

Fig. 19.



First larva of Polynema.

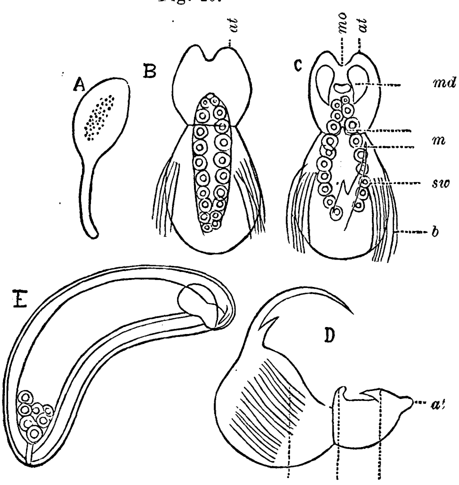
The development of Ophioneurus, another egg-parasite, agrees with that of Platygaster and Polynema. This egg-parasite passes its early life in the eggs of *Pieris brassicæ*, and two or three live to reach the imago state, though about six eggs are deposited by the female. The eggs are oval, and not stalked. The larva is at first of the form indicated by Fig. 20 *E*, and when fully grown becomes of a broad oval form, the body not being divided into segments. It differs from the genera already mentioned, in remaining within its egg membrane, and not assuming their strange forms. From the non-segmented, sac-like larva, it passes directly into the pupa state.

The last egg-parasite noticed by Ganin, is Teleas, whose development resembles that of Platygaster. It is a parasite in the eggs of Gerris, the Water Boatman. Fig. 20 *A* represents the egg; *B*, *C*, and *D*, the first stage of the larva, the abdomen (or posterior division of the body) being furnished with a series of bristles on each side. (*B* represents the ventral, *C* the dorsal, and *D* the profile view; *at*, antennæ; *md*, hook-like mandibles; *mo*, mouth; *b*, bristles; *m*, intestine; *sw*, the tail; *ul*, under lip, or labium). In the second larval stage, which is oval in form, and non-segmented, the primitive band is formed.

In concluding the account of his remarkable discoveries, Ganin

draws attention to the great differences in the formation of the egg and the germ of these parasites from what occurs in other insects. The egg has no nutritive cells; the formation of the primitive band, usually the first indication of the germ, is retarded till the second larval stage is attained; and the embryonal membrane is not homologous with the so-called "amnion" of other insects, but may possibly be compared with the skin developed on the upper side of the germ of the low, worm-like acarian, Pentastomum, and the "larval skin" of the embryos of many low Crustacea. He says, also, that we cannot, perhaps, find the homologues of the provisional organs of the larvæ, such as the singularly shaped antennæ, the claw-like mandibles, the tongue- or ear-like appendages, in other Arthropoda (insects and Crustacea); but that they may be found in the parasitic Lernean crustaceans, and in the leeches, such as Histriobdella. He is also struck by the similarity in the development of these egg-parasites to that of a kind of leech (Nephelis), the embryo of which is provided with ciliæ, recalling the larva of Teleas (Fig. *B*, *C*,), while in the true leeches (Hirudo) the primitive band is not developed until after they have passed through a provisional larval stage.

Fig. 20.



Development of Egg-parasite.

This complicated metamorphosis of the egg-parasites, Ganin also compares to the so-called "hyper-metamorphosis" of certain insects (Meloe, Sitaris, and the Stylopidæ) made known by Siebold, Newport and Fabre, and he considers it to be of the same nature.

He also, in closing, compares such early larval forms as those given in Figs. 17 and 19 to the free swimming Copepoda. Finally, he says a few words on the theory of evolution, and remarks

"there is no doubt that, if a solution of the questions arising concerning the genealogical relations of different animals among themselves is possible, comparative embryology will afford the first and truest principles." He modestly suggests that the facts presented in his paper will widen our views on the genetic relations of the insects to other animals, and refers to the opinion first expressed by Fritz Müller (Für Darwin, p. 91), and endorsed by Hæckel in his "Generelle Morphologie," that we must seek for the ancestors of insects and Arachnida in the Zoëa form of Crustacea. He cautiously remarks, however, that "the embryos and larvæ observed by me in the egg-parasites, open up a new and wide field for a whole series of such considerations; but I will suppress them, since I am firmly convinced that a theory which I build up to-day, can easily be destroyed with some few facts which I learn to-morrow. Since comparative embryology as a science does not yet exist, so do I think that all genetic theories are too premature, and without a strong scientific foundation."

The reviewer is perhaps less cautious, but he cannot refrain from making some reflections suggested by the remarkable discoveries of Ganin. In the first place, these facts bear strongly on Cope and Hyatt's theory of evolution by "acceleration and retardation." In the history of these early larval stages we see a remarkable acceleration, or hurrying up, of the embryo. A simple sac of unorganized cells, with a half-made intestine, so to speak, is hatched, and made to do the duty of an ordinary, quite highly organized larva. Even the formation of the "primitive band," usually the first indication of the organization of the germ, is postponed to a comparatively late period in larval life. The different anatomical systems, the heart, with its vessels, the nervous system, and the respiratory system (tracheæ), appear at longer or shorter intervals, while in one genus, the tracheæ are not developed at all. Thus some portions of the animal are accelerated in their development more than others, while others are retarded, and in others still certain organs are not developed at all. Meanwhile all live in a fluid medium, with much the same habits, and surrounded with quite similar physical conditions.

The highest degree of acceleration is seen in the reproductive organs of the Cecidomyian larva of Miastor, which produces a summer brood of young, alive, and which live free in the body of the child-parent; and in the pupa of Chironomus, which has been

recently shown by Von Grimm, a fellow countryman of Ganin, to produce young in the spring, while the adult fly lays eggs in the autumn in the usual manner. This is in fact a true virgin reproduction, and directly comparable to the alternation of generations observed in the jelly fishes, in Salpa, and certain intestinal worms. We can now, in the light of the researches of Ganin, Siebold, Leuckart, and others, trace more closely than ever the connection between simple growth and metamorphosis, and metamorphosis and parthenogenesis, and perceive that they are but the terms of a single series. By the acceleration of a single set of organs (the reproductive), no more wonderful than the acceleration and retardation of the other systems of organs, so clearly pointed out in the embryos of Platygaster and its allies, we see how parthenogenesis under certain conditions may result. The barren Platygaster larva, the fertile Cecidomyia larva, the fertile Aphis larva, the fertile Chironomus pupa, the fertile hydroid polyp, and the fertile adult queen bee, are simply animals in different degrees of organization, and with reproductive systems differing not in quality, but in the greater or less rapidity of their development as compared with the rest of the body.

Another interesting point is, that while the larvæ vary so remarkably in form, the adult ichneumon flies are remarkably similar to one another. Do the differences in their larval history seem to point back to certain still more divergent ancestral forms?

These remarkable hyper-metamorphoses remind us of the metamorphosis of the embryo of Echinoderms into the Pluteus- and Bipinnaria-forms of the star-fish, sea-urchins, and Holothuriæ; of the Actinotrocha-form larva of the Sipunculoid worms; of the Cercaria-form larva of Distoma; of the Pilidium-form larva of Nemertes; and the larval forms of the leeches;* as well as the acarian Pentastomum, and certain other aberrant mites, such as Myobia, and in a less degree certain other more highly organized mites, such as Atax, and Hydrachna, and the ticks, which may almost be said to pass through a hyper-metamorphosis.

While Fritz Müller and Dohrn have considered the insects as having descended from the Crustacea (some primitive zoëa-form),

* Leuckart, in his great work, "Die Menschlichen Parasiten," p. 700, after the analogy of Hirudo, which develops a primitive streak late in larval life, ventures to consider the first indications of the germ of Nemertes in its larval, Pilidium-form as a primitive streak. He also suggests that the development of the later larval forms of the Echinoderms is the same in kind.

and Dohrn has adduced the supposed zoëa-form larva of these egg-parasites as a proof, we cannot but think in a subject so purely speculative as the ancestry of animals, that the facts brought out by Ganin tend to confirm the reviewer's theory, expressed in the last number of this journal, that the ancestry of all the insects (including the Arachnids and Myriapods) should be traced directly to the worms. The development of the degraded, aberrant arachnidan Pentastomum accords, in some important respects, with that of the intestinal worms. The Leptus-form larva of Julus, with its strange embryological development, in some respects so like that of some worms, points in that direction, as certainly as does the embryological development of the egg-parasite Ophioneurus. The Nauplius form of the embryo or larva of all Crustacea, also points back to the worms as their ancestors, the divergence having perhaps originated in the Rotatoria. In these similar modes of development between the worms and the Crustacea on the one hand, and the worms and insects on the other, have we not a strong genetic bond uniting these three great classes into one grand subkingdom; and can we not in imagination perceive the successive steps by which the Creator, acting through the secondary laws of evolution, has built up the great articulate division of the animal kingdom? — A. S. P.

NATURAL HISTORY MISCELLANY.

BOTANY.

Transpiration of Aqueous Vapor by the Leaves of Plants. — Professor McNab of Cirencester College, England, has recently published an important series of experiments on this subject. The plant experimented on was in all cases the common cherry-laurel (*Prunus laurocerasus*), and the fluid to determine the rapidity of ascent, lithium citrate, a very small quantity of which can be detected by means of the spectroscope. Dr. McNab divided the results under the following heads: — 1. Quantity of water in the leaves. The mean of several experiments gave 63.4 per cent. 2. Quantity of water which can be removed by calcium chloride, or